(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号

特開平9－257069

(43)公開日　平成９年(1997)９月30日

(51)Int.Cl.[6]	識別記号	庁内整理番号	Ｆ Ｉ	技術表示箇所
Ｆ１６Ｆ　1/10			Ｆ１６Ｆ　1/10	
Ｂ２９Ｃ　70/06			Ｂ２９Ｃ　67/14	Ｕ
// Ｂ２９Ｋ 105:08				

審査請求　有　　請求項の数19　ＯＬ　（全 14 頁）

(21)出願番号　特願平8－64935

(22)出願日　平成８年(1996)３月21日

(71)出願人　000226242
日機装株式会社
東京都渋谷区恵比寿３丁目43番２号

(72)発明者　伊東　孝彦
神奈川県横浜市都筑区池辺町3998　株式会社雪ヶ谷制御研究所内

(72)発明者　武田　秀夫
東京都渋谷区恵比寿３丁目43番２号　日機装株式会社内

(72)発明者　吉田　健次
静岡県榛原郡榛原町静谷498番１　日機装株式会社静岡製作所内

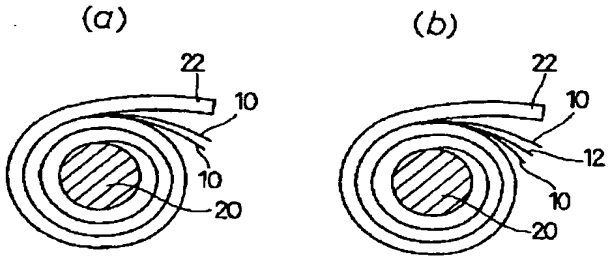
(74)代理人　弁理士　浜田　治雄

(54)【発明の名称】　渦巻きばね

(57)【要約】

【課題】　長繊維の特定の配向状態による繊維強化樹脂からなる複合材を形成し、この複合材を機械的に変形させることにより比較的大容量の機械的エネルギーの蓄積を可能とし、しかも前記複合材の変形を復元させる際に、蓄積された機械的エネルギーを効率良く放出して各種の動力源として有効に活用することができる渦巻きばねを提供する。

【解決手段】　複数本の長繊維と、これを帯状に保持するマトリックス樹脂からなる複合材から構成し、外部のエネルギー源および／または負荷から与えられる回転動作の機械的エネルギーを主として長繊維の弾性歪エネルギーとして蓄積し、所要時に前記蓄積された弾性歪エネルギーを機械的エネルギーとして取出してエネルギー源を補助するように、渦巻きばねを構成する。また、前記複合材により外側と内側の表面層部１０、１０を構成すると共に、両表面層部に挟まれて両表面層間の距離を維持するための軽量材料からなる中間層部１２を設け、これを渦巻き状に成形して構成する。



【特許請求の範囲】
【請求項１】　複数本の長繊維と、これを帯状に保持するマトリックス樹脂からなる複合材で構成し、外部のエネルギー源および／または負荷から与えられる回転動作の機械的エネルギーを主として長繊維の弾性歪エネルギーとして蓄積し、所要時に前記蓄積された弾性歪エネルギーを機械的エネルギーとして取出してエネルギー源を補助するように構成することを特徴とする渦巻きばね。
【請求項２】　負荷による渦巻きばねに対するエネルギーの蓄積は、負荷へのブレーキ作用時に負荷が有するエネルギーを回収して渦巻きばねに与えるように構成してなる請求項１記載の渦巻きばね。
【請求項３】　長繊維は、引張り弾性率が４０，０００ｋｇｆ／ｍｍ² 以下であり、引張り強度が２５０ｋｇｆ／ｍｍ² 以上である繊維から主として構成してなる請求項１記載の渦巻きばね。
【請求項４】　長繊維は、帯状の長手方向に配向してなる請求項１記載の渦巻きばね。
【請求項５】　複合材は、少なくとも二層からなり、各層内でそれぞれ長繊維が同一方向に配列されてなる請求項１記載の渦巻きばね。
【請求項６】　長繊維が、帯状の長手方向に対して±１３．５度以内の傾きで長手方向に配列されてなる請求項４または５に記載の渦巻きばね。
【請求項７】　渦巻き状に巻回された帯状の外側に位置する長繊維が、アラミド繊維、炭素繊維、ガラス繊維、ポリエチレン繊維から選択される少なくとも一種の繊維であり、内側に位置する部分においては、炭素繊維、ガラス繊維、ボロン繊維、炭化珪素繊維から選択される少なくとも一種の繊維である請求項１ないし６のいずれかに記載の渦巻きばね。
【請求項８】　外側と内側の表面層部を、複数の長繊維とそれを帯状に保持するマトリックスとからなる複合材で構成し、中間層部を前記表面層部より軽量化したことを特徴とする渦巻きばね。
【請求項９】　中間層部に、中空部分を形成してなる請求項８記載の渦巻きばね。
【請求項１０】　中間層部を、中空部分を有する軽量材料で構成してなる請求項８記載の渦巻きばね。
【請求項１１】　軽量材料の中空部分を、マイクロバルーンで構成してなる請求項９記載の渦巻きばね。
【請求項１２】　長繊維は、引張り弾性率が４０，０００ｋｇｆ／ｍｍ² 以下であり、引張り強度が２５０ｋｇｆ／ｍｍ² 以上である繊維から主として構成してなる請求項８記載の渦巻きばね。
【請求項１３】　長繊維は、帯状の長手方向に配向してなる請求項８記載の渦巻きばね。
【請求項１４】　両表面層部の複合材は、それぞれ少なくとも二層からなり、各層内でそれぞれ長繊維が同一方向に配列されてなる請求項８記載の渦巻きばね。
【請求項１５】　長繊維は、帯状の長手方向に対して±１３．５度以内の傾きで長手方向に配列されてなる請求項１３または１４に記載の渦巻きばね。
【請求項１６】　渦巻き状に巻回された帯状の外側に位置する表面層部の長繊維が、アラミド繊維、炭素繊維、ガラス繊維、ポリエチレン繊維から選択される少なくとも一種の繊維であり、内側に位置する表面層部の長繊維が、炭素繊維、ガラス繊維、ボロン繊維、炭化珪素繊維から選択される少なくとも一種の繊維である請求項８ないし１５のいずれかに記載の渦巻きばね。
【請求項１７】　軽量材料からなる中間層部の厚さが、両表面層部の平均厚さの０．２～６倍からなる請求項８記載の渦巻きばね。
【請求項１８】　軽量材料からなる中間層部の厚さが、外側表面層部の０．６～５倍からなる請求項８記載の渦巻きばね。
【請求項１９】　外部のエネルギー源および／または負荷から与えられた回転の機械的エネルギーを、主として長繊維の弾性歪みエネルギーとして蓄積し、所用時に蓄積された前記エネルギーを機械的エネルギーとして取り出してエネルギー源を補助するように構成してなる請求項８記載の渦巻きばね。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は、複合材料を単層でまたは積層して板状に形成して、機械的変位をエネルギーとして蓄積すると共に、蓄積したエネルギーを動力源として使用することができる渦巻き（ぜんまい）ばねおよびその応用に関するものである。
【０００２】
【従来の技術】従来より、一般的に機械的エネルギーを蓄積し、そしてこの蓄積したエネルギーを適宜放出することができる手段として、次のものが知られている。
【０００３】(1) ゴム：ゴムの重量当りの弾性歪エネルギーは、各種繊維に匹敵するが、変形量が大きく、また常温で酸化されて脆くなり易く、耐久性に問題があるため、模型飛行機の動力源以外には余り使用されていない。また、形態安定性が悪いため、渦巻き（ぜんまい）ばねに成形することは困難である。
【０００４】(2) 金属ばね：金属ばねは、重量当りの弾性歪エネルギー蓄積容量が低く、各種高張力繊維の１／５０～１／１００程度しかない、しかし、成形性が良いために、エネルギー容量が小さくてよいものや、その重量を気にしなくてもよい用途、例えば玩具、時計、手巻き式蓄音機、オルゴール、手動ラジオ等の手動式単独エネルギー源に使用されるのみであり、軽量かつ大容量を必要とする用途あるいは別個に存在するエネルギー源を補助するいわゆるハイブリッド駆動源としては、使用されていない。
【０００５】(3) 複合材料ばね：スプリングやダンパ等

の用途を目的としたＦＲＰ（繊維強化樹脂）により構成したエネルギー吸収体が提案されている（特公昭５９－４０１０１号公報）。この吸収体は、繊維強化によって材料の強度および弾性率を高めるものであるが、振動としての機械的エネルギーを吸収し、これをできるだけ熱エネルギーに変換して外部に放出することにより振動を減衰させるものであり、強化材を保持する母材としては粘弾性特性に優れている（粘性成分のウエイトが高い）必要がある。しかし、このエネルギー吸収体は、例えば回転の機械的エネルギーを効率よく蓄積し、この蓄積したエネルギーを、エネルギー損失なく再び回転の機械的エネルギーとして放出して利用すること、すなわちハイブリッド駆動源とするために、動力エネルギーを蓄積することを目的としたものではない。

【０００６】また、ＦＲＰ渦巻きばねも知られているが（特開平１－１２０４４８号公報）、これは両側に織物またはマットを使用することにより、ばねの割れを防ぎ、耐へたり性、疲労強度の改善、弾性率の改善を行ったものである。このように、織物やマットを併用することにより、蓄積エネルギーの絶対値はともかくとして、ばねの長手方向に対して直角方向の繊維が、重量または体積当りの蓄積エネルギーにとってマイナスとなることは考慮されてはいない。また、用途としても、往運動で蓄えたエネルギーを復運動の駆動源としたり、手動巻上げで蓄えたエネルギーを駆動源として利用するもののみであり、例えば別個に駆動源があって、必要な時に駆動源を補助したり、駆動源にとっての負荷を平準化したり（ロードレベリング）するような用途、すなわちハイブリッド駆動源としての用途は見当たらない。

【０００７】(4) フライホイール：フライホイールは、運動エネルギーの形で大容量のエネルギーを蓄積することが可能であるが、解決されていない問題も多く、実用技術として完成されたものではない。

【０００８】(5) 蓄電池：蓄電池は、蓄積エネルギー密度は高いが、機械的エネルギーを蓄積して利用するためには、発電機と電動機とを別個に、あるいは両機能を備えた機－電変換器を必要とし、経済的な面以外にも各変換ステップでの効率が問題となる。

【０００９】

【発明が解決しようとする課題】そこで、発明者等は、鋭意研究を重ねた結果、長繊維を一方向に配列して帯状の繊維強化樹脂（ＦＲＰ）からなる複合材を形成し、この複合材を両側の強度を保持するための表面層部とし、これら両表面層の間に厚みを保持するための軽量材料から形成される中間層部を設けてこれを挟持し、これらを層状の板として形成して、これにより渦巻きばねを構成することにより、渦巻きばねとして機械的エネルギーをその重量や体積に対して大量に蓄積すると共に、この蓄積エネルギーを効率良く放出して広く動力源として活用することができることを突き止めた。

【００１０】従って、本発明の目的は、長繊維の特定の配向状態による繊維強化樹脂からなる複合材を形成し、この複合材を機械的に変形させることにより比較的大容量の機械的エネルギーの蓄積を可能とし、しかも前記複合材の変形を復元させる際に、蓄積された機械的エネルギーを効率良く放出して各種の動力源として有効に活用することができる渦巻きばねを提供することにある。

【００１１】

【課題を解決するための手段】前記目的を達成するため、本発明に係る渦巻きばねは、複数本の長繊維と、これを帯状に保持するマトリックス樹脂からなる複合材で構成し、外部のエネルギー源および／または負荷から与えられる回転動作の機械的エネルギーを主として長繊維の弾性歪エネルギーとして蓄積し、所要時に前記蓄積された弾性歪エネルギーを機械的エネルギーとして取出してエネルギー源を補助するように構成することを特徴とする。

【００１２】この場合、長繊維は、引張り弾性率を４０，０００ｋｇｆ／ｍｍ^2 以下とし、引張り強度を２５０ｋｇｆ／ｍｍ^2 以上とする繊維から主として構成することができる。

【００１３】しかるに、引張り弾性率は、好適には３１，０００ｋｇｆ／ｍｍ^2 以下であり、さらに好ましくは６，０００～２５，０００ｋｇｆ／ｍｍ^2 である。一方、引張り強度は、好適には３４０ｋｇｆ／ｍｍ^2 以上であり、さらに好ましくは５００ｋｇｆ／ｍｍ^2 以上である。

【００１４】また、長繊維は、帯状の長手方向に配向すれば好適である。この場合、繊維は、すだれ織りや組紐状に形成されているものも使用することができる。

【００１５】一方、複合材は、少なくとも二層からなり、各層内でそれぞれ長繊維が同一方向に配列されるように構成することができる。

【００１６】この場合、長繊維は、帯状の長手方向に対して±１３．５度以内の傾きで長手方向に配列されるように構成することができる。

【００１７】さらに、渦巻き状に巻回された帯状の外側に位置する長繊維は、アラミド繊維、炭素繊維、ガラス繊維、ポリエチレン繊維から選択される少なくとも一種の繊維とし、内側に位置する部分においては、炭素繊維、ガラス繊維、ボロン繊維、炭化珪素繊維から選択される少なくとも一種の繊維とすることができる。

【００１８】また、本発明に係る渦巻きばねは、外側と内側の表面層部を、複数の長繊維とそれを帯状に保持するマトリックスとからなる複合材で構成し、中間層部を前記表面層部より軽量化することを特徴とする。

【００１９】この場合、内側の繊維は、フィラメント径の大きい方が蓄積エネルギーが高くなるので好ましい。

【００２０】また、前記中間層部は、中空部分を形成することができる。前記中間層部は、中空部分を有する軽

量材料で構成することができる。そして、前記軽量材料の中空部分は、マイクロバルーンで構成することができる。

【００２１】さらに、前記長繊維は、引張り弾性率を４０，０００ｋｇｆ／ｍｍ² 以下とし、引張り強度を２５０ｋｇｆ／ｍｍ² 以上とする繊維から主として構成することができる。

【００２２】そして、この場合に長繊維は、帯状の長手方向に配向すれば好適であり、またすだれ織りや組紐状に形成されている繊維を使用することもできる。

【００２３】一方、前記両表面層の複合材は、少なくとも二層からなり、各層内でそれぞれ長繊維が同一方向に配列されるように構成することができる。

【００２４】さらに、前記長繊維は、帯状の長手方向に対して±１３．５度以内の傾きで長手方向に配列されるように構成することができる。

【００２５】また、渦巻きばねは、渦巻き状に巻回された帯状の外側に位置する表面層部の長繊維を、アラミド繊維、炭素繊維、ガラス繊維、ポリエチレン繊維から選択される少なくとも一種の繊維とし、内側に位置する表面層部の長繊維が、炭素繊維、ガラス繊維、ボロン繊維、炭化珪素繊維から選択される少なくとも一種の繊維とすることができる。

【００２６】この場合も、内側の繊維は、フィラメント径の大きい方が蓄積エネルギーが高くなるので好ましい。

【００２７】なお、前記軽量材料からなる中間層部の厚さは、両表面層部の平均厚さの０．２～６倍とすることができる。

【００２８】また、前記軽量材料からなる中間層部の厚さは、外側表面層部の０．６～５倍とすることができる。

【００２９】

【発明の実施の形態】本発明において、渦巻きばねを成形するに際しては、基本的に、繊維強化樹脂用プリプレグを１層または２層以上積層したシートを使用して、これを渦巻き状に成形し、加熱・加圧処理することにより達成することができる。

【００３０】また、本発明においては、前記単層または２層以上に積層したプリプレグの一側面または中間に、軽量材料からなる層を設けて、これを渦巻き状に成形し、加熱・加圧処理することにより、渦巻きばねを成形することができる。

【００３１】しかるに、本発明の繊維強化樹脂に使用する材料として、特に渦巻きばねの用途として好ましい繊維の限定はないが、例えば渦巻きの外側では、引っ張りに強いガラス繊維、炭素繊維、アラミド繊維等が好ましく、一方内側の補強繊維としては、圧縮に強い炭素繊維、ボロン繊維が好ましい。これらの繊維から得られるばねは、いずれも蓄積エネルギー容量が大きい。また、前記軽量材料からなる軽量層を設ける場合においても、これらの繊維が好適に使用される。

【００３２】また、前記繊維強化樹脂に使用するマトリックス材料としては、熱硬化性樹脂として、エポキシ樹脂、フェノール樹脂、ポリイミド樹脂、ビスマレイミド樹脂等を使用することができ、また熱可塑性樹脂として、ポリスルフォン樹脂、ポリエステル樹脂、フッ素系樹脂、ポリアミド樹脂、ポリアセタール樹脂、ポリフェニルスルフィド、ポリエーテルケトン、ポリエーテルスルフォン等を使用することができる。特に、これらの樹脂類のなかでも、結晶性が高く、粘性変形し難いものが好ましい。その他、セラミックスや金属も使用可能であるが、これらは重量当りのエネルギー蓄積容量の点から樹脂類よりも劣る。

【００３３】本発明の繊維強化樹脂を構成するためのプリプレグとしては、市販の一方向プリプレグを使用することができる。また、繊維を所要角度を有する一方向に配列されたものを得るには、フィラメントワインダーを使用して、所定の角度に配向したプリプレグとすることができる。この場合、市販の一方向プリプレグを使用して、積層時に所定の角度を持たせるように構成することもできる。また、表面層部を複数層から形成させる場合には、層毎に角度を変えることも可能であり、一層毎に正逆の角度を持たせてもよい。この場合、前記角度は、エネルギー蓄積容量からは、ばねの長手方向に対して１２度付近が最も好ましいが、角度設定をしない（０度の）ものに比べて生産性は劣る。

【００３４】繊維が織物の場合は、プリプレグを所定の幅に切断して使用するか、中間層部と積層後、または積層成形後に所定の幅に切断する。但し、この場合、通常の織物や編物は、重量当りエネルギーの点から好ましくない。

【００３５】また、操業の点からは、所々に横糸を入れて縦糸をシート状に纏めた、いわゆるすだれ織りは、横糸量が僅少なために、一方向プリプレグ用として良好に使用することができる。

【００３６】さらに、プリプレグを使用しなくても、樹脂液を浸漬した糸を、ある角度でフィラメントワインダーによりマンドレルに巻着けて組紐状となったものは、正負の角度のものが入交じっており、各層の糸角度が一定とは言い難いが、使用可能である。しかし、このフィラメントワインダーを使用する方式は、生産性の点から余り好ましくはない。

【００３７】本発明の渦巻きばねにおいては、軽量材料からなる中間層部を設けることによって、比較的蓄積エネルギーの小さい繊維を使用しても比較的大きいエネルギー容量の渦巻きばねを得ることができる。

【００３８】前記中間層部としての軽量材料からなる軽量層としては、マイクロバルーン含有材料やハニカムを使用することができるが、製造作業からは、マイクロバ

ルーン含有材料の使用が便利である。マイクロバルーンとしては、ガラスバルーンやシラスバルーンが好適である。例えば、ガラスバルーンをエポキシマトリックスに分散して、比重を０．１２５～０．６ｇ／ｃｃとしたものが市販されている。マトリックス樹脂としては、何等制限がなく、各種の公知のものが使用可能である。また、発泡樹脂も使用可能である。

【００３９】そして、マイクロバルーンを中間層部に使用する時は、予め樹脂に対して１０～２０％（重量比。容量比では１０～６０％）混合し、必要な厚さに成形して、マトリックスが熱硬化性樹脂の場合は予めＢステージ化しておき、これを、表面層部としての、繊維を含有したプリプレグと積層して成形する。

【００４０】また、ハニカムを中間層部として使用することも可能である。この場合、ハニカムの厚さ方向を中間層部の厚さ方向として使用する。そこで、ばねの厚さの小さいものでは、製造作業性に問題があるが、厚さが数ｍｍ以上の時には、特に数ｃｍ以上ある大容量のばねでは、好適に使用することができる。

【００４１】なお、この中間層部には、繊維を織物状で使用しても、容量当りの蓄積エネルギーを下げることがないので、ばねの幅方向の補強用に使用することができる。この場合、比重の小さい繊維のものが、重量を増やさない点から好ましい。また、例えば前記中間層部に使用する樹脂に発泡剤を混入しておき、成形時の加熱により発泡させることにより、前記中間層部は、中空部分を有する軽量材料で構成することができる。

【００４２】本発明の渦巻きばねの成形に際しては、熱可塑性樹脂を使用する場合は、プレス成形により各層（表面層部、中間層部）を融着し、必要な形に成形する。熱硬化性樹脂を使用する場合は、例えば所定の厚さのシリコンゴムからなるスペーサと積層物を重ね、伊達巻き式に巻き込んで、真空包装し、オートクレーブで加圧下に加熱して硬化させて成形する。この場合、シリコンゴムの厚さに勾配を付けることにより、自然状態での渦巻きの周回間のピッチを外側と内側とで変えることができる。

【００４３】また、プルトルージョンによる成形を行う場合には、熱可塑性樹脂では温度が未だ十分に冷える前に、熱硬化性樹脂では完全硬化前に押出された成形品を、スペーサ（例えば、耐熱シリコンゴムシート）と重ねて軸に巻取り、しかる後に冷却または再硬化させて成形する。この成形方式は、前記熱硬化性樹脂によるプリプレグ成形方式より、生産性の点で優れている。

【００４４】なお、前記各スペーサを使用する成形方式において、前記スペーサは、シリコンゴム以外のものとして、エアバッグ等を使用することが可能である。

【００４５】また、渦巻きばね形状として利用し得る構成とする際には、巻取り、巻戻しにおけるばね各周回間の接触を避けるために、外から内に向って剛性を小さく設定することができる。この場合、幅を一定にして、厚さに勾配を持たせるか、厚さを一定にして、幅に内から外へ勾配を持たせるようにする。

【００４６】さらに、本発明において、前記各層（表面層部、中間層部）を平板状のままとし、板ばね形状として利用し得る構成とすることもできる。

【００４７】

【実施例】次に、本発明に係る渦巻きばねの実施例につき、添付図面を参照しながら以下詳細に説明する。

【００４８】実施例１

炭素繊維〔東レ（株）製のＴ３００〕にエポキシ樹脂（未硬化状態）を含浸させて、その繊維方向が長手方向に対して±０°となるようにプリプレグ２層を積層してなるプリプレグ積層物１０、１０（長さ２，５００ｍｍ、幅５０ｍｍ、厚さ０．５ｍｍ）を作成した。

【００４９】このようにしてプリプレグ２層を積層して作成したプリプレグ積層物１０、１０は、図１の（ａ）に示すように、直径が２０ｍｍの金型２０の周囲にシリコン板２２と共に各周回間を等ピッチ間隔にして巻着した。

【００５０】前記積層物を全て巻着した後、図２に示すように、その外側をポリエステル製の加圧テープ２４で巻着し、ナイロン製のフィルムにより真空パックを行う。その後、オートクレーブに入れ、温度１３０℃、圧力３ｋｇ／ｃｍ^3 ｇの加熱・加圧条件により、１２０分間保持して硬化させた。

【００５１】得られた物について、加圧テープ２４、シリコン板２２および金型２０を順次取外すことにより、外周の直径が１５０ｍｍの積層物からなる渦巻きばねを得た。

【００５２】実施例２

プリプレグ積層物１０の作成に際し、繊維方向を長手方向に対して±１２°となるように２層に積層した構成とし、その他の構成は実施例１と全て同一として、プリプレグ積層物を作成した。次いで、ガラスのマイクロバルーンを充填したエポキシ樹脂のフィルム１２〔日本石油（株）製マイクロプライＳＦ－６〕（長さ２，５００ｍｍ、幅５０ｍｍ、厚さ１．５ｍｍ）を作成した。

【００５３】このようにして作成したプリプレグ積層物１０、１０とフィルム１２とは、図１の（ｂ）に示すように、前記フィルム１２を中間層部とし、その両側を前記プリプレグ積層物１０、１０で挟持するよう積層し、この積層物を金型２０の周囲にシリコン板２２と共に巻着した。

【００５４】前記積層物を全て巻着した後、前記実施例１と同一の製造条件により、渦巻きばねを得た。

【００５５】実施例３

プリプレグ積層物１０の作成に際し、繊維方向を長手方向に対して±０°となるように２層に積層した構成とし、その他の構成は実施例１と全て同一として、プリプ

レグ積層物を作成した。その他の構成材料および製造条件は、前記実施例２と全て同一にして、渦巻きばねを得た。

【００５６】実施例４

渦巻きばねの外側の表面層部を形成するプリプレグ積層物１０の作成に際し、実施例１の炭素繊維に代えてアラミド繊維〔米国デュポン社製のＫＥＶＬＡＲ－４９〕にエポキシ樹脂（未硬化状態）を含浸させて、その繊維方向が長手方向に対して±１３°となるように２層に積層してなるプリプレグ積層物１０、１０（各層部について、長さ２，５００ｍｍ、幅５０ｍｍ、厚さ０．５ｍｍ）を作成した。その他の構成材料（内側の表面層部と中間層部）および製造条件は、前記実施例２と全て同一にして、渦巻きばねを得た。

【００５７】比較例

長さ２，５００ｍｍ、幅５０ｍｍ、厚さ０．５ｍｍのばね鋼を使用し、これを所要の金型に渦巻き状に巻着し、この状態のまま熱処理を行って、渦巻きばねを得た。

【００５８】Ａ．重量当り蓄積エネルギーについての試験

実施例１～４および比較例においてそれぞれ得られた渦巻きばねについて、重量当り蓄積エネルギーについての試験を行った。

【００５９】試験方法

試料として外周の直径が１５０ｍｍの渦巻きばねＳを、図３に示すように、その内端を直径が１５ｍｍの芯棒３０に固定し、その外端をケース３２の内側に固定し、そして前記芯棒３０に巻き着けたワイヤ３４を、テンション万能引張り試験器により矢印方向に引張っていった時の、荷重と変位とを計測した。

【００６０】まず、計測に際しては、同一のサンプルを５個作成し、それらをそれぞれ破壊するまで引張った時に、破壊歪みが最大となったサンプルの破壊歪みの８０％の歪みに対応した各サンプルの重量当り蓄積エネルギー（ｋｇ・ｃｍ／ｋｇ）を、加重－変位曲線の下側面積から求めた。これらを、各実施例について実施した。なお、各渦巻きばねは、外周が固定され、内側から巻き取っているので、ばねの各周間の摩擦が少なく、歪み－応力特性曲線がほぼ直線を示し、前記曲線下の面積は、三角法で求めることができた。これらの試験結果を表１に示す。

【００６１】また、歪みを破壊にまで至らせずに、ヒステリシス特性を描く場合、戻りの勾配は往きと同じであり、それぞれヒステリシスは僅少であることが認められた。

【００６２】試験結果

【表１】

実施例（番号）		1	2	3	4	比較例
積層構成	外側	＊ CFRP 0°	＊ CFRP±12°	＊ CFRP 0°	＊＊ KFRP 13°	ばね鋼
	中間	—	樹脂フィルム	樹脂フィルム	樹脂フィルム	—
	内側	CFRP 0° ＊	CFRP±12° ＊	CFRP 0° ＊	CFRP 0° ＊	—
重　量（kg）		0.19	0.31	0.31	0.30	0.98
比　重		1.5	1.0	1.0	0.9	7.8
蓄積エネルギー（kg-cm）		3.04 ×10³	6.18 ×10³	5.96 ×10³	5.87 ×10³	0.37 ×10³
重量当り蓄積エネルギー（kg-cm/kg）		1.57 0 ×10⁴	2.02 ×10⁴	1.95 ×10⁴	2.06 ×10⁴	0.04 ×10⁴

＊　CFRP：炭素繊維強化エポキシ樹脂

＊＊　KFRP：アラミド繊維強化エポキシ樹脂

【００６３】上記の重量当り蓄積エネルギーの試験結果から、本発明に係る実施例１～４で得られる渦巻きばねは、従来の比較例における渦巻きばねと比較して、約５０倍以上の重量当り蓄積エネルギーを発揮し得ることが確認された。

【００６４】Ｂ．繊維角度と重量当り蓄積エネルギーとの関係

実施例２による渦巻きばねの製造に際し、繊維の長手方向に対する角度を種々変更した場合における、繊維角度α（°）と重量当り蓄積エネルギー（ｋｇ・ｃｍ／ｋｇ）について測定した結果、図４に示す特性が得られた。この特性結果から、前記繊維角度が±１２°付近において、重量当り蓄積エネルギーは最大値となること、そしてこの角度は±１３．５度以内であることが好ましいことが確認された。

【００６５】Ｃ．中間層部／表面層部の厚さと重量当り蓄積エネルギーとの関係

実施例２による渦巻きばねの製造に際し、外側表面層部の厚さｔ１、内側表面層部の厚さｔ３、中間層部の厚さｔ２について種々変更し、重量当り蓄積エネルギー（ｋｇ・ｃｍ／ｋｇ）について測定した。

【００６６】まず、外側表面層部の厚さｔ１に対する中間層部の厚さｔ２の比（ｔ２／ｔ１）について測定した結果、図５に示す特性が得られた。この特性結果から、外側表面層部の厚さｔ１に対する中間層部の厚さｔ２の比１．５～３の範囲において最大値が得られることが判った。

【００６７】外側表面層部の厚さｔ１および内側表面層部の厚さｔ３を共に０．０４ｃｍとした場合において、中間層部の厚さｔ２＝０～０．２５ｃｍに変化させた時について測定した結果、図６に示す特性が得られた。この特性結果から、中間層部の厚さｔ２＝０．０２５～０．２ｃｍの範囲、すなわち中間層部の厚さが両表面層部の平均厚さに対して０．６～５倍の範囲で最大値が得られること、一方、ｔ３／ｔ１が１．２５においてその最大値が極大を示し、また最大値が存在するｔ３／ｔ１の範囲がほぼ０．５～３であることが判った。なお、この場合、ガラス繊維強化樹脂、アラミド繊維強化樹脂お

いる。さらに、外側支持ケース４６の一部は、前記内側保持ケース部４４ａ、４４ｂ、４４ｃおよび内側保持ケース４４の内周部まで延在するスリーブ４６′を備え、このスリーブ４６′に対してそれぞれ前記各内側保持ケース部４４ａ、４４ｂ、４４ｃおよび内側保持ケース４４が、軸受５２、５３を介して回転自在に保持されている。

【００９３】また、本応用例において、内側保持ケース４４は、ブレーキドラム７０ａ、ブレーキシュー７０ｂおよびブレーキカム７０ｃからなるブレーキ結合機構７０を介して外部ハウジング４８と結合すると共に、ワンウェイクラッチ５４を介して回転軸４０と係合している。

【００９４】その他の構成は、基本的に前記図７に示すものと同様である。従って、この図９に示す応用例においても、その動作は前記図７に示す応用例と基本的に同一であり、渦巻きばねを多連に構成した点で、弾性歪みエネルギーの蓄積容量および放出容量を増大し得る点に特徴がある。

【００９５】前述したように、本発明の渦巻きばねの構成によれば、蓄積エネルギーを従来のものより大幅に高めることができる。従って、この渦巻きばねを利用して、エネルギー蓄積装置を製造する場合には、前記渦巻きばねの能力を十分に活用できる構造とする必要がある。そして、渦巻きばねの破壊歪みを検討し、この歪みまたはその近くにまで、ばねが歪み得るようにハウジングおよび巻取軸を設計する必要がある。少なくとも普通の場合は、巻取軸の直径は成形金型の直径より小さい必要がある。また、ある場所が最も早く破壊に近い点まで歪んだ時には、他の部分も殆ど破壊に近いところまで歪んでいるように設計することが、蓄積エネルギーを高めることになる。このためには、ばねの内側の周回と外側の周回とで、破壊時点での曲率を実験により求め、それによりほぼ同時に破壊歪みに達するように、周回間のピッチを設計することが望ましい。

【００９６】なお、量産されたばねの破壊歪みには、当然にバラツキが存在する。従って、使用範囲はバラツキを考慮した安全圏内でなければならない。例えば、平均破壊歪みの８０％以上の歪みを受けないように、巻取軸の直径を設定したり、回転停止装置もしくはスリップ装置を適宜設ける。

【００９７】また、本発明の渦巻きばねにおいては、外側のハウジングと内側の巻取軸の間で歪みを受ける。渦巻きばねの複数個を直列にして使用する場合は、一つのばねのハウジング側と巻取軸側とを順次連結させる。この場合、ハウジングと巻取軸とにより、外側と内側のばね直径が規制される。しかし、このような規制のない装置、例えばハウジングのない巻取りスプール方式では、ばねの外側が引出されると共に、その外周が小さくなり、ばねの各周回が軸方向に同時に集合していくので、周回間に摩擦が生じる。このため、ばねの伸縮に際して大きなヒステリシスを生じる。

【００９８】しかしながら、ハウジングが存在すると、外周は変わらないままで、巻取軸の回転と共に各周回が順次内に向かって移動し、摩擦は比較的に少なく、このためにヒステリシスも僅少である。これにより、エネルギーの蓄積放出効率も高くなる。

【００９９】なお、ばねの内側または外側の弾性率を小さくすることにより、ヒステリシスを小さくすることができる。また、ばねの内側と外側とを機械的加工によって摩擦抵抗を下げることにより、ヒステリシスを小さくすることもできる。さらに、ばねの内側ないし外側に、パラフィン系オイル等のマトリックスを変化させない潤滑剤を表面に付着させることによっても、摩擦抵抗を下げてヒステリシスを小さくすることができる。

【０１００】さらに、本発明の渦巻きばねにおいては、ばね変形において、外側表面層部では引張り変形が生じ、内側表面層部では圧縮変形が生じ、そして厚み方向の中間部では曲がるだけで、長さ方向の変形のない部分が生じる。使用される材料の能力を精一杯活用するためには、変形によって破壊される時には、全ての材料が破壊点に達していることが好ましい。従って、前記長さ変形しない部分より外側（外側表面層部）では、引張り変形に強いものが好ましく、長さ変形しない部分より内側（内側表面層部）では、圧縮変形に強いものが好ましい。また、それぞれにおいて表面に向かって破壊変形の大きなものとすることが好ましい。この様にして、繊維および樹脂を選択することができる。

【０１０１】そして、各層部は、必ずしも層状でなくてもよいが、表面から中間部に向かって繊維を変えることも、生産性の問題を無視すれば好ましい。各層部が、複数の層からなっている場合は、このような変更は比較的に容易である。具体的には、例えば外側表面層部の外側層をアラミド繊維やガラス繊維を使用し、内側層を炭素繊維とし、内側表面層部の表面側（ばねの内側）に炭素繊維を使用し、内側（ばねの中間部側）にボロン繊維や炭化珪素繊維を使用することにより、両層部全層が同時に破壊するように形成するのも好ましい態様である。

【０１０２】なお、内側表面層部の内側層と表面層とを、繊維は同じであって、繊維のフィラメント径を表面層で太いものを使用することにより、耐圧縮性を高めて同時破壊性を高めることもできる。また、中空の中間層部が存在する場合も同様に構成することができる。

【０１０３】以上、本発明の好適な実施例について説明したが、本発明は前記実施例に限定されることなく、本発明の精神を逸脱しない範囲内において、多くの設計変更をなし得ることは勿論である。

【０１０４】なお、従来のエネルギー変換機構を利用したハイブリッド駆動装置としては、例えば自転車では予め充電された電池と電動機を搭載して、坂道で人力を補

助するものであったり、発電機、蓄電池、電動機（あるいは発電機と電動機を一体化した交流機）を使用するハイブリッド駆動式自動車であったりする。これに対して、本発明の渦巻き（ぜんまい）ばねにおいては、回転力を回転力のまま蓄積し、そのまま回転力として利用するものであり、エネルギーの変換がなく、そのため余分な装置が不要である。従って、本発明の渦巻きばねは、従来のばねに比べて、蓄積エネルギーが著しく改善されており、ハイブリッド駆動の有用な手段として使用することができる。

【０１０５】

【発明の効果】前述した実施例から明らかなように、本発明に係る渦巻き（ぜんまい）ばねは、複数本の長繊維と、これを帯状に保持するマトリックス樹脂からなる複合材から構成し、外部の駆動源および／または負荷から与えられる回転動作の機械的エネルギーを主として長繊維の弾性歪エネルギーとして蓄積し、所要時に前記蓄積された弾性歪エネルギーを機械的エネルギーとして取出して駆動源を補助するように構成するものであって、例えば前記複合材により外側と内側の表面層部を構成すると共に、両表面層部に挟まれて両表面層間の距離を維持するための軽量材料からなる中間層を設け、これを渦巻き状に成形して渦巻きばねを構成することにより、前記複合材を機械的に変形させることによって、比較的大容量の機械的エネルギーの蓄積を可能とし、しかも前記複合材の変形を復元させる際に、蓄積された機械的エネルギーを効率良く放出して各種の動力源として有効に活用することができる。

【０１０６】また、本発明の渦巻きばねは、中間軽量層部を設ける時は、重量当りの蓄積エネルギーを改善し、さらに中間軽量層を設けない場合は、容量当りの蓄積エネルギーを改善する。このため、長繊維として、その織物や編み物、不織布を使用すると、改善効果を下げるので好ましくない。繊維は、実質的にばねの長手方向にのみ配向されていることが好ましい。

【０１０７】従って、本発明に係る渦巻きばねは、これをエネルギーの蓄積・放出を行う動力源等に適用した装置に応用することにより、負荷の変化をレベリングしたり、エネルギー源の変化をレベリングする手段として、以下に例示するように広範囲の分野において利用することができる。

【０１０８】（１）負荷の変化をレベリングする手段

ａ．前途の高負荷が予想される時に、前もって駆動源に無理を掛けることなく少しづつエネルギーを蓄積しておき、高負荷時の駆動源を補助する。例えば、路線バス等においては、ナビゲータと連動させて、予めプログラムしておくことによって、登坂用エネルギーを用意することが可能である。また、自転車においては、前方の長い登坂が見えた時に、その手前から出力を少しづつ上げて、渦巻きばねを巻いてエネルギーを蓄積し、登坂時に蓄積エネルギーを放出することができる。

【０１０９】ｂ．低負荷時の余剰回転エネルギーを渦巻きばねに蓄積し、高負荷時にエネルギー源を補助する。例えば、電力需要の少ない時に余剰電力で渦巻きばねを巻いてエネルギーを蓄積し、電力需要の大きい時に放出することにより、電力負荷平準化に利用することができる。

【０１１０】ｃ．ブレーキング時に、通常は熱として放散される機械的エネルギーを、渦巻きばねに蓄積し、これにより通常の回転時のエネルギー源を補助する。例えば、自動車、自転車、電車の降坂や減速の時に渦巻きばねを巻いてエネルギーを蓄積し、登坂や加速の時に蓄積エネルギーを放出する。なお、エレベータも同様に適用可能であり、エネルギー源であれば、必ずしもそれは物を駆動するものに限定されない。

【０１１１】（２）エネルギー源の変化をレベリングする手段

ａ．風力発電において、強風時の駆動に際しエネルギーを渦巻きばねに蓄積し、無風時ないし低風時の駆動に際し蓄積エネルギーを放出して発電出力の平準化を達成する。

【０１１２】ｂ．潮流発電において、電池に代替して渦巻きばねを使用し、この渦巻きばねにエネルギーを蓄積し、無潮流ないし低潮流の時に際し蓄積エネルギーを放出して発電出力の平準化を達成する。

【図面の簡単な説明】

【図１】本発明に係る渦巻きばねの製造工程の一実施例を示す概略側面図である。

【図２】図１に示す渦巻きばねの製造工程中の状態を示す概略斜視図である。

【図３】本発明に係る渦巻きばね等の試料について試験方法を示す説明図である。

【図４】本発明に係る渦巻きばねの繊維角度と重量当り蓄積エネルギーとの関係を示す特性線図である。

【図５】本発明に係る渦巻きばねの外側表面層の厚さに対する中間層の厚さの比と重量当り蓄積エネルギーとの関係を示す特性線図である。

【図６】本発明に係る渦巻きばねの外側表面層の厚さに対する中間層の厚さの変化と重量当り蓄積エネルギーとの関係を示す特性線図である。

【図７】本発明に係る渦巻きばねの応用に際しての基本原理を示す概略説明図である。

【図８】本発明に係る渦巻きばねの応用に際しての端部の処理手段の一実施例を示す要部説明図である。

【図９】図７に示す本発明に係る渦巻きばねの具体的な応用例を示す概略説明図である。

【符号の説明】

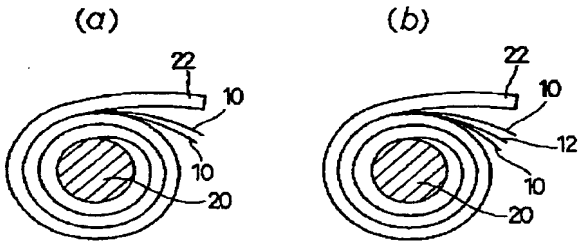
１０　プリプレグ積層物（表面層部）

１２　フィルム（中間層部）

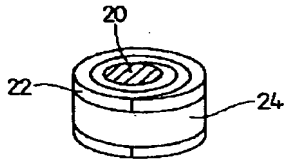
２０　金型

２２　シリコン板
２４　加圧テープ
３０　芯棒
３２　ケース
３４　ワイヤ
４０　回転駆動軸
４０ａ　駆動源
４０ｂ　被動体
４２　渦巻きばね
４２ａ～４２ｄ　渦巻きばね
４３　渦巻きばねの端部
４４　内側支持ケース
４４ａ～４４ｃ　内側支持ケース部
４６　外側保持ケース
４６′　スリーブ
４６ａ～４６ｃ　外側保持ケース部
４７ａ～４７ｃ　連結ケース
４８　外部ハウジング
４８ａ　一端側の結合部
４８ｂ　他端側の結合部
５０、５１　軸受
５２、５３、５５　軸受
５４　ワンウェイクラッチ
５６　クラッチ
５８　ワンウェイクラッチ
６０　ブレーキ結合部
６４、６５　端部補強部材
６５ａ　先端部
６６　クラッチ機構
６６ａ　クラッチフォーク
６６ｂ　クラッチスラスト軸受
６６ｃ　多板クラッチ
７０　ブレーキ結合機構
７０ａ　ブレーキドラム
７０ｂ　ブレーキシュー
７０ｃ　ブレーキカム

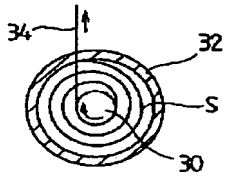
【図１】



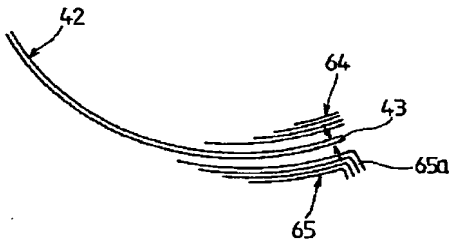
【図２】



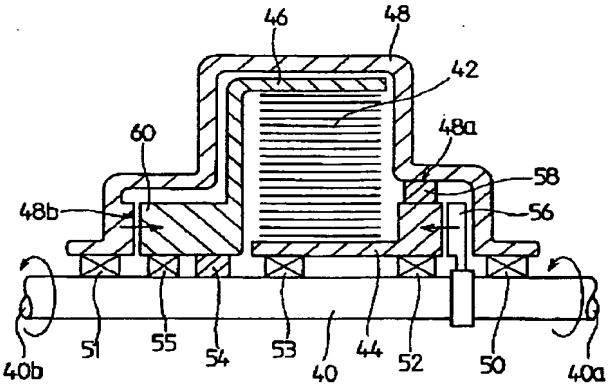
【図３】



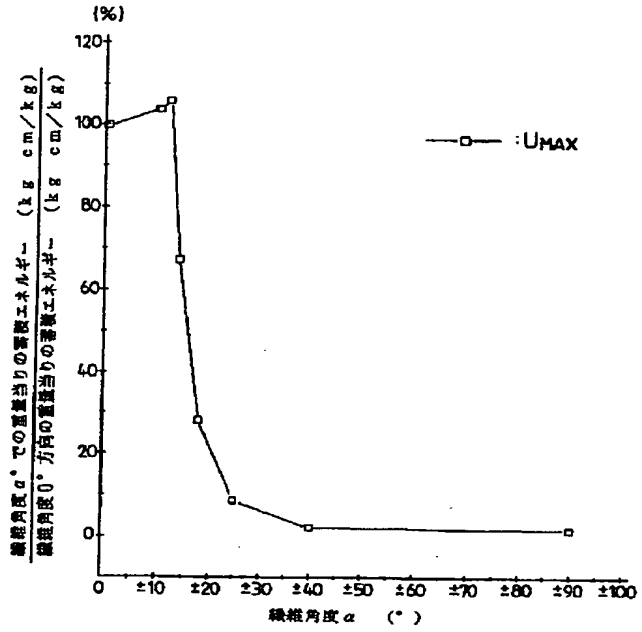
【図８】



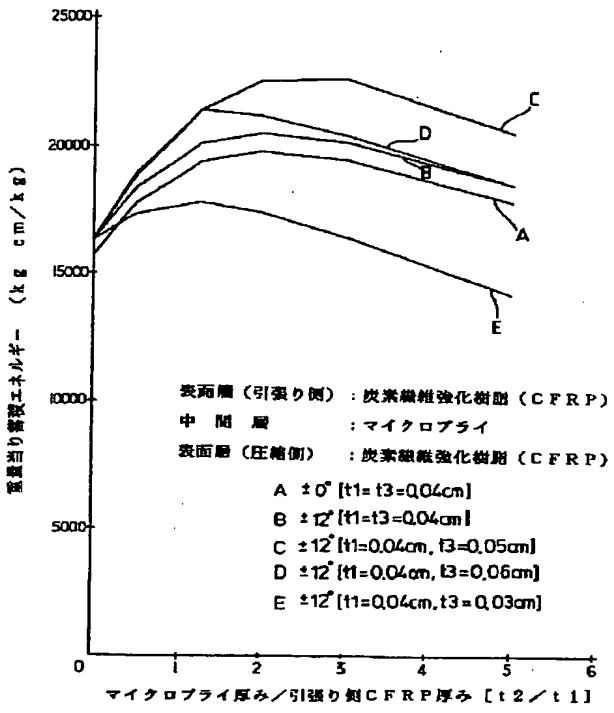
【図７】



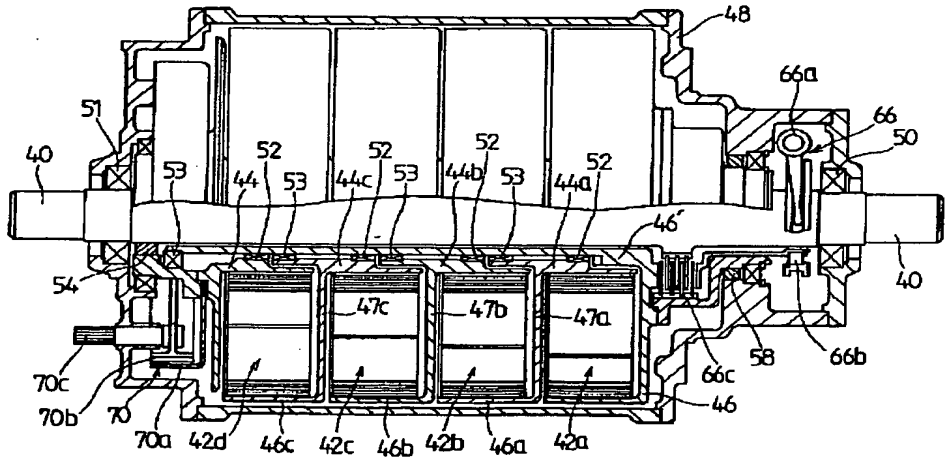
【図4】


(%)
120
100
80
60
40
20
0
:UMAX
0 ±10 ±20 ±30 ±40 ±50 ±60 ±70 ±80 ±90 ±100
繊維角度α (°)
繊維角度α°での重量当りの吸収エネルギー (kg cm/kg)
繊維角度0°方向の重量当りの吸収エネルギー (kg cm/kg)

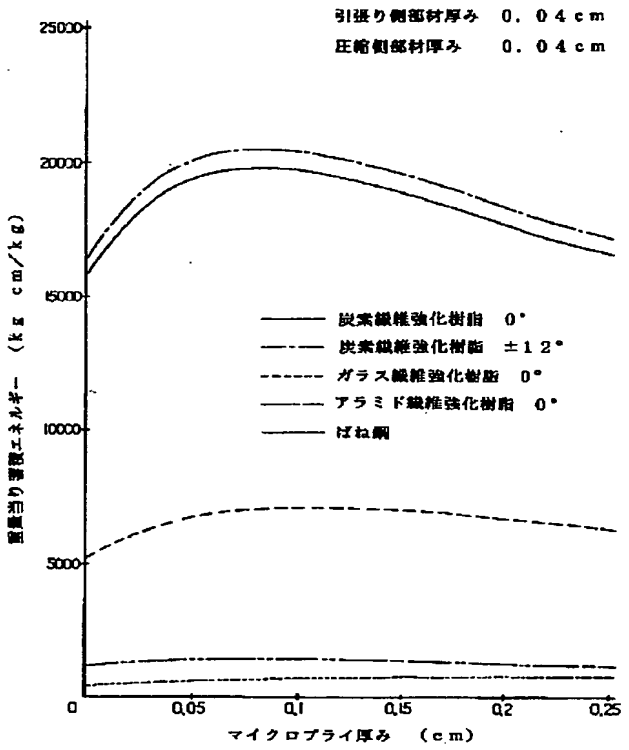
【図5】


25000
20000
15000
10000
5000
0
1 2 3 4 5 6
重量当り吸収エネルギー (kg cm/kg)
マイクロプライ厚み／引張り側CFRP厚み [t2／t1]
C
D
B
A
E
表面層（引張り側）：炭素繊維強化樹脂（CFRP）
中間層　：マイクロプライ
表面層（圧縮側）：炭素繊維強化樹脂（CFRP）
A ±0° [t1=t3=0.04cm]
B ±12° [t1=t3=0.04cm]
C ±12° [t1=0.04cm, t3=0.05cm]
D ±12° [t1=0.04cm, t3=0.06cm]
E ±12° [t1=0.04cm, t3=0.03cm]

【図9】


48
66a
66
50
51
40
53
52
44
44c
44b
44a
46'
54
47c
47b
47a
58
66b
66c
46
70c
70b
70
70a
42d
46c
42c
46b
42b
46a
42a

【図６】


引張り側部材厚み　０．０４ｃｍ
圧縮側部材厚み　０．０４ｃｍ
炭素繊維強化樹脂　０°
炭素繊維強化樹脂　±１２°
ガラス繊維強化樹脂　０°
アラミド繊維強化樹脂　０°
ばね鋼
重量当り歪吸エネルギー　（ｋｇ　ｃｍ／ｋｇ）
25000
20000
15000
10000
5000
0
0.05
0.1
0.15
0.2
0.25
マイクロプライ厚み　（ｃｍ）

of JP09257069 from JPO website

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[The technical field to which invention belongs] It whirls (spiral spring) and it is the spring and the thing about the application which can use the accumulated energy as a source of power while this invention's being a monolayer, or carrying out the laminating of the composite material, forming it in a tabular and accumulating mechanical displacement as energy.
[0002]
[Description of the Prior Art] Before, generally a mechanical energy is accumulated and the following are known as a means which can emit this accumulated energy suitably.
[0003] (1) Rubber : although it is equal to various fiber, since it is large, and deformation oxidizes in ordinary temperature, and tends to become weak and a problem is in endurance, the elastic strain energy per weight of rubber is seldom used in addition to the source of power of a model airplane. Moreover, since form stability is bad, it is difficult to whirl (spiral spring) and to fabricate for a spring.
[0004] (2) Metal spring : a metal spring has a low elastic-strain-energy storage capacitance per weight, and has about 1 of various high tension fiber / 50 to 1/100. However, since the moldability is good, energy capacity is [only being used for manual system independent energy sources, such as a small thing, and the use which does not need to care about the weight, for example, a toy, a clock, a hand volume formula phonograph, a music box, manual radio, and], and is not used as lightweight and the so-called hybrid driving source which assists the use which needs large capacity, or the energy source which exists separately.
[0005] (3) Composite-material spring : the energy-absorption object constituted by FRP (fiber strengthening resin) aiming at the use of a spring, a damper, etc. is proposed (JP,59-40101,B). Although this absorber raises the intensity and the elastic modulus of material by fiber strengthening, by absorbing the mechanical energy as vibration, changing this into heat energy as much as possible, and emitting outside, it attenuates vibration and has the need of holding a reinforcement and of excelling in viscoelastic property as a base material (the weight of a viscous component being high). However, this energy-absorption object is not a thing aiming at accumulating a rotational mechanical energy efficiently, and accumulating power energy, in order to carry out to emitting this accumulated energy as a rotational mechanical energy again without energy loss, and using it, i.e., a hybrid driving source.
[0006] Moreover, although the FRP swirl spring is also known (JP,1-120448,A), by using textiles or a mat for both sides, this prevents the crack of a spring and makes the improvement of setting-proof nature and fatigue strength, and an improvement of an elastic modulus. Thus, the fiber of the right-angled direction is not considered as minus and a bird clapper for the stored energy per a weight or volume to the longitudinal direction of a spring noting that it writes also with the absolute value of a stored energy by using textiles and a mat together. Moreover, a use which energy conserved by ****** also as a use is made into the driving source of ******, or the energy conserved by manual winding is used as a driving source, and there is a driving source separately, for example, assists a driving source when required, or equalizes the load for a driving source (load leveling), or is carried out, i.e., the use as a hybrid driving source, is not found.
[0007] (4) Flywheel : although a flywheel can accumulate energy mass in the form of kinetic energy, there were also many problems which are not solved and they were not completed as practical use technology.
[0008] (5) Battery : although stored-energy density of a battery is high, in order to accumulate and use a mechanical energy, need opportunity-******** equipped with both functions separately [motor / a generator and], and the efficiency in each conversion step poses a problem besides an economical field.
[0009]
[Problem(s) to be Solved by the Invention] Then, an artificer etc. forms the composite which arranges a continuous glass fiber to ** on the other hand, and consists of a band-like fiber strengthening resin (FRP), as a result of repeating research wholeheartedly. Make this composite into

the surface-layer section for holding the intensity of both sides, prepare the interlayer section formed from the lightweight material for holding thickness among both [these] surface layers, pinch this, and these are formed as a stratified board. While accumulating the mechanical energy in large quantities to the weight and volume by this whirling and constituting a spring as a swirl spring, it traced that this stored energy could be emitted efficiently and it could utilize as a source of power widely.

[0010] Therefore, the purpose of this invention is to offer the whorl spring which can form the composite which consists of a fiber strengthening resin by the specific orientation state of a continuous glass fiber, can emit efficiently the mechanical energy accumulated when enabling accumulation of a comparatively mass mechanical energy and restoring deformation of the aforementioned composite moreover by making this composite transform mechanically, and can be effectively utilized as various kinds of sources of power.

[0011]

[Means for Solving the Problem] It is characterized by to constitute so that may constitute the whorl spring applied to this invention in order to attain the aforementioned purpose from a composite which consists of two or more continuous glass fibers and a matrix resin which holds this to band-like, it may accumulate the mechanical energy of rotation operation given from an external energy source and/or an external load mainly as an elastic strain energy of a continuous glass fiber, may take out the elastic strain energy by which accumulation was carried out [aforementioned] at the time of necessary as a mechanical energy and an energy source may be assisted.

[0012] In this case, a continuous glass fiber is a tension elastic modulus 40,000 kgf(s)/mm 2 It considers as the following and is tensile strength 250 kgf(s)/mm 2 It can mainly constitute from fiber considered as the above.

[0013] however, a tension elastic modulus -- suitable -- 31,000kgf/mm2 the following -- it is -- further -- desirable -- 6,000-25,000kgf/mm2 it is . On the other hand, tensile strength is 2 340 kgf (s)/mm suitably. It is above and is 2 500 kgf(s)/mm still more preferably. It is above.

[0014] Moreover, if orientation of the continuous glass fiber is carried out to a band-like longitudinal direction, it is suitable. In this case, what is formed blind weave and in the shape of a braid can be used for fiber.

[0015] On the other hand, a composite consists of a bilayer at least, and it can be constituted so that a continuous glass fiber may be arranged in the same direction within each class, respectively.

[0016] In this case, a continuous glass fiber can be constituted so that it may be arranged by the longitudinal direction with the inclination of less than **13.5 degrees to a band-like longitudinal direction.

[0017] Furthermore, the continuous glass fiber located in the band-like outside wound in the shape of a whorl can be made into a kind of fiber chosen from an aramid fiber, a carbon fiber, a glass fiber, and a polyethylene fiber at least, and let it at least be a kind of fiber chosen from a carbon fiber, a glass fiber, a boron fiber, and a silicon carbide fiber in the portion located inside.

[0018] Moreover, the whorl spring concerning this invention constitutes the surface-layer section of an outside and the inside from a composite which consists of two or more continuous glass fibers and a matrix which holds it to band-like, and is characterized by lightweight-izing the interlayer section from the aforementioned surface-layer section.

[0019] In this case, since inside fiber becomes high, the one of a stored energy where the diameter of a filament is larger is desirable [fiber].

[0020] Moreover, the aforementioned interlayer section can form a part for a centrum. The aforementioned interlayer section can consist of lightweight material which has a part for a centrum. And a part for the centrum of the aforementioned lightweight material can consist of micro balloons.

[0021] Furthermore, the aforementioned continuous glass fiber is a tension elastic modulus 40,000 kgf(s)/mm 2 It considers as the following and is tensile strength 250 kgf(s)/mm 2 It can mainly constitute from fiber considered as the above.

[0022] And if orientation of the continuous glass fiber is carried out to a band-like longitudinal direction in this case, it is suitable, and the fiber currently formed blind weave and in the shape of a braid can also be used.

[0023] On the other hand, the composite of both the aforementioned surface layers consists of a

bilayer at least, and it can be constituted so that a continuous glass fiber may be arranged in the same direction within each class, respectively.
[0024] Furthermore, the aforementioned continuous glass fiber can be constituted so that it may be arranged by the longitudinal direction with the inclination of less than **13.5 degrees to a band-like longitudinal direction.
[0025] Moreover, a whorl spring can make at least the continuous glass fiber of the surface-layer section located in the band-like outside wound in the shape of a whorl a kind of fiber chosen from an aramid fiber, a carbon fiber, a glass fiber, and a polyethylene fiber, and the continuous glass fiber of the surface-layer section located inside can make it at least a kind of fiber chosen from a carbon fiber, a glass fiber, a boron fiber, and a silicon carbide fiber.
[0026] Since a stored energy becomes [the one where the diameter of a filament is larger] high also in this case, inside fiber is desirable.
[0027] In addition, thickness of the interlayer section it is thin from the aforementioned lightweight material can be made into 0.2 to 6 times of the average thickness of both the surface-layers section.
[0028] Moreover, thickness of the interlayer section it is thin from the aforementioned lightweight material can be made into 0.6 to 5 times of the outside surface-layer section.
[0029]
[Embodiments of the Invention] In this invention, it can face fabricating a whorl spring, the sheet which carried out the laminating of the prepreg for fiber strengthening resins one layer or more than two-layer can be used fundamentally, this can be fabricated in the shape of a whorl, and it can attain heating and by carrying out pressure treatment.
[0030] Moreover, in this invention, the layer which consists of lightweight material can be prepared in the unilateral side of a prepreg or middle which carried out the laminating more than the aforementioned monolayer or two-layer, this can be fabricated in the shape of a whorl, and a whorl spring can be fabricated heating and by carrying out pressure treatment.
[0031] However, as a material used for the fiber strengthening resin of this invention, a glass fiber strong against hauling, a carbon fiber, an aramid fiber, etc. are desirable, and, on the other hand, a carbon fiber strong against compression and a boron fiber are desirable as inside reinforcement fiber, although there is especially no limitation of fiber desirable as a use of a whorl spring on the vortical outside, for example. Each spring obtained from these fiber has a large stored-energy capacity. Moreover, when preparing the lightweight layer which consists of the aforementioned lightweight material, these fiber is used suitably.
[0032] Moreover, as a matrix material used for the aforementioned fiber strengthening resin, as thermosetting resin, an epoxy resin, phenol resin, polyimide resin, a bismaleimide resin, etc. can be used, and a polysulfone resin, polyester resin, a fluorine system resin, polyamide resin, polyacetal resin, a polyphenyl sulfide, a polyether ketone, a polyether sulfone, etc. can be used as thermoplastics. Crystallinity is high also in these resins especially, and what cannot carry out viscous deformation easily is desirable. In addition, although a ceramic metallurgy group is also usable, these are inferior to resins from the point of the energy storage capacitance per weight.
[0033] The commercial 1 direction prepreg can be used as a prepreg for constituting the fiber strengthening resin of this invention. Moreover, in order to obtain the thing which has a necessary angle for fiber and which was arranged by ** on the other hand, a filament winder can be used and it can consider as the prepreg which carried out orientation to the predetermined angle. In this case, the commercial 1 direction prepreg can be used, and it can also constitute so that a predetermined angle may be given at the time of a laminating. Moreover, when making the surface-layer section form from two or more layers, it is also possible to change an angle for every layer, and the angle of right reverse may be given for every monostromatic. In this case, although near 12 degrees is the most desirable to the longitudinal direction of the spring from an energy storage capacitance as for the aforementioned angle, compared with what (0 times) does not carry out an angle setup, productivity is inferior.
[0034] When fiber is textiles, a prepreg is cut and used for predetermined width of face, or it cuts to predetermined width of face after the interlayer section, a laminating, or laminate molding. However, usual textiles or usual knitting are not desirable from the point of energy per weight in this case.
[0035] Moreover, on the other hand, the amount of weft can use the so-called blind weave which put

the weft into some places from the point of operation, and packed warp in the shape of a sheet for eye a small hatchet good as an object for ** prepregs.
[0036] Furthermore, it is usable, although it is mixed by the thing of the angle of positive/negative and the thread angle of each class cannot say as regularity what became winding **** braid-like by the filament winder at a certain angle about the thread immersed in resin liquid at the mandrel easily, even if it does not use a prepreg. However, the method which uses this filament winder is not so desirable from the point of productivity.
[0037] In the swirl spring of this invention, by preparing the interlayer section which consists of lightweight material, even if it uses fiber with a comparatively small stored energy, the swirl spring of comparatively large energy capacity can be obtained.
[0038] As a lightweight layer which consists of lightweight material as the aforementioned interlayer section, although micro balloon content material and a honeycomb can be used, use of the micro balloon content material from fabrication operation is convenient. As a micro balloon, a glass balloon and a milt balloon are suitable. For example, a glass balloon is distributed to an epoxy matrix and what carried out specific gravity in 0.125-0.6g/cc is marketed. As a matrix resin, there is no limit in any way and various kinds of well-known things are usable. Moreover, a foaming resin is also usable.
[0039] And when using a micro balloon for the interlayer section, it is [as opposed to / a resin / beforehand] 10 - 20% (weight ratio.). Mixture is carried out 10 to 60%, and it fabricates in required thickness, and when a matrix is thermosetting resin, B stage is formed beforehand, the laminating of this is carried out to the prepreg containing the fiber as the surface-layer section, and it is fabricated in a capacity factor.
[0040] Moreover, it is also possible to use a honeycomb as the interlayer section. In this case, the thickness direction of a honeycomb is used as a thickness direction of the interlayer section. Then, although a problem is in fabrication operation nature in what has the small thickness of a spring, especially when thickness is several mm or more, it can be suitably used with a certain mass spring several cm or more.
[0041] In addition, since the stored energy per capacity is not lowered to it even if it uses fiber for this interlayer section by the shape of textiles, it can be used for reinforcement of the cross direction of a spring. In this case, the thing of fiber with small specific gravity is desirable from the point which does not increase a weight. Moreover, the aforementioned interlayer section can consist of lightweight material which has a part for a centrum by mixing the foaming agent in the resin used, for example for the aforementioned interlayer section, and making it foam by heating at the time of fabrication.
[0042] When using thermoplastics on the occasion of fabrication of the swirl spring of this invention, each class (surface-layer section, interlayer section) is welded by press forming, and it fabricates in a required form. When using thermosetting resin, the spacer and laminated material which consist of silicone rubber of predetermined thickness are piled up, it involves in a date-rolls formula and vacuum-packs, and it is made to heat and harden under pressurization and fabricates with an autoclave. In this case, the pitch during the circumference of the swirl in a natural state is changeable by the outside and the inside by attaching inclination to the thickness of silicone rubber.
[0043] moreover, the mold goods extruded before full hardening in thermosetting resin before temperature still got cold fully in thermoplastics, when fabrication by the protrusion rod was performed -- a spacer (for example, heat-resistant silicon rubber sheet) -- in piles -- a shaft -- rolling round -- after an appropriate time -- cooling -- or it is made to re-harden and fabricates This forming method is excellent in respect of [method / prepreg fabrication / by the aforementioned thermosetting resin] productivity.
[0044] In addition, in the forming method which uses each aforementioned spacer, the aforementioned spacer can use an air bag etc. as things other than silicone rubber.
[0045] Moreover, in case it considers as the composition which can be used as a swirl spring configuration, in order to roll round and to avoid the contact during spring each circumference in rewinding, rigidity can be small set up toward inside from outside. In this case, width of face is fixed, inclination is given to thickness, or thickness is fixed and inclination is given to width of face outside from inside.

[0046] Furthermore, in this invention, aforementioned each class (surface-layer section, interlayer section) can be considered as as [plate-like], and it can also consider as the composition which can be used as a flat spring configuration.
[0047]
[Example] Next, it explains to a detail below about the example of the swirl spring concerning this invention, referring to an accompanying drawing.
[0048] The epoxy resin (state where it does not harden) was infiltrated into example 1 carbon fiber [T300 by Toray Industries, Inc.], and the prepreg laminated materials 10 and 10 (0.5mm in a length of 2,500mm, width of face of 50mm, thickness) which carry out the laminating of the prepreg two-layer, and become so that the grain direction may become **0 degree to a longitudinal direction were created.
[0049] Thus, as shown in (a) of drawing 1 , with the silicon board 22, the diameter made the prepreg laminated materials 10 and 10 which carried out the laminating of the prepreg two-layer, and created it the pitch [between / each circumference] interval, and wound them around the circumference of the metal mold 20 which is 20mm.
[0050] After winding all the aforementioned laminated materials, as shown in drawing 2 , the outside is wound on the pressurization tape 24 made from polyester, and the film made of nylon performs a vacuum packing. Then, it puts into an autoclave, and it held for 120 minutes and was made to harden according to heating / pressurization conditions of the temperature of 130 degrees C, and pressure 3 kg/cm3 g.
[0051] About the obtained object, by demounting the pressurization tape 24, the silicon board 22, and metal mold 20 one by one, the diameter of a periphery consisted of a laminated material which is 150mm, it whirled, and the spring was obtained.
[0052] Considering the grain direction as the composition which carried out the laminating to two-layer on the occasion of creation of the example 2 prepreg laminated material 10, so that it might become **12 degrees to a longitudinal direction, other composition created the prepreg laminated material as altogether the same as that of an example 1. Subsequently, micro ply SF[by film 12 [Nippon Oil Co., Ltd.]-6] (1.5mm in a length of 2,500mm, width of face of 50mm, thickness) of the epoxy resin filled up with the micro balloon of glass was created.
[0053] Thus, as shown in (b) of drawing 1 , the prepreg laminated materials 10 and 10 and film 12 which were created made the aforementioned film 12 the interlayer section, and it carried out the laminating so that the both sides might be pinched by the aforementioned prepreg laminated materials 10 and 10, and they wound this laminated material around the circumference of metal mold 20 with the silicon board 22.
[0054] After winding all the aforementioned laminated materials, the whorl spring was obtained according to the same manufacture conditions as the aforementioned example 1.
[0055] Considering the grain direction as the composition which carried out the laminating to two-layer on the occasion of creation of the example 3 prepreg laminated material 10, so that it might become **0 degree to a longitudinal direction, other composition created the prepreg laminated material as altogether the same as that of an example 1. Another component and other manufacture conditions were altogether made the same with the aforementioned example 2, and obtained the whorl spring.
[0056] Creation of the prepreg laminated material 10 which forms the surface-layer section of the outside of an example 4 whorl spring is faced. Replace with the carbon fiber of an example 1 and an epoxy resin (state where it does not harden) is infiltrated into an aramid fiber [KEVLAR-49 by U.S. Du Pont]. The prepreg laminated materials 10 and 10 (the class section 0.5mm in a length of 2,500mm, width of face of 50mm, thickness) which carry out a laminating to two-layer and become it so that the grain direction may become **13 degrees to a longitudinal direction were created. Another component (the inside surface-layer section and the inside interlayer section) and other manufacture conditions were altogether made the same with the aforementioned example 2, and obtained the whorl spring.
[0057] Spring steel with an example length of comparison of 2,500mm, a width of face [of 50mm], and a thickness of 0.5mm was used, this was wound around necessary metal mold in the shape of a whorl, it heat-treated with this state, and the whorl spring was obtained.

[0058] A. About the whorl spring obtained in the examination examples 1-4 about a stored energy, and the example of comparison, respectively per weight, the examination about a stored energy was performed per weight.

[0059] The whorl spring S whose diameter of a periphery is 150mm as a test-method sample was fixed to the arbor 30 whose diameter is 15mm about an edge as shown in drawing 3 , the outer edge was fixed inside the case 32, and a load and a variation rate when a tension omnipotent tensile test machine pulls the wire 34 rolled and stuck to the aforementioned arbor 30 in the direction of an arrow were measured.

[0060] First, when it pulled on the occasion of measurement until it created the five same samples and destroyed them, respectively, it asked for the stored energy (kg-cm/kg) from the bottom area of a load-displacement curve per weight of each sample corresponding to distortion of 80% of breaking-strain Mino of a sample where destructive distortion became the maximum. These were carried out about each example. In addition, since the periphery was fixed and each whorl spring was rolled round from the inside, there could be little friction between each periphery of a spring, it was able to be distorted, - stress characteristic curve was able to show the straight line mostly, and it was able to ask for the area under the aforementioned curve by trigonometry. These test results are shown in Table 1.

[0061] Moreover, when a hysteresis characteristic was drawn without making distortion result even in destruction, the inclination of return is the same as going, and it was admitted, respectively that a hysteresis was small.

[0062] Test result [Table 1]

実施例（番号）		1	2	3	4	比較例
積層構成	外側	＊ CFRP 0°	＊ CFRP±12°	＊ CFRP 0°	＊＊ KFRP 13°	ばね鋼
	中間	—	樹脂フィルム	樹脂フィルム	樹脂フィルム	—
	内側	CFRP 0° ＊	CFRP±12° ＊	CFRP 0° ＊	CFRP 0° ＊	—
重　量（kg）		0.19	0.31	0.31	0.30	0.98
比　重		1.5	1.0	1.0	0.9	7.8
蓄積エネルギー（kg-cm）		3.04 ×10³	6.18 ×10³	5.96 ×10³	5.87 ×10³	0.37 ×10³
重量当り蓄積エネルギー（kg-cm/kg）		1.57 0 ×10⁴	2.02 ×10⁴	1.95 ×10⁴	2.06 ×10⁴	0.04 ×10⁴

＊　CFRP：炭素繊維強化エポキシ樹脂

＊＊　KFRP：アラミド繊維強化エポキシ樹脂

[0063] It was checked from the test result of a stored energy per above-mentioned weight that the whorl spring obtained in the examples 1-4 concerning this invention can demonstrate a stored energy per weight of about 50 times or more as compared with the whorl spring in the conventional example of comparison.

[0064] B. As a result of measuring about a stored energy (kg-cm/kg) per weight with fiber angle alpha (degree) at the time of changing various fiber angles and angles [as opposed to the longitudinal direction of fiber on the occasion of manufacture of the whorl spring according to the related example 2 with a stored energy per weight], the property shown in drawing 4 was acquired. From this property result, it was checked that it is desirable that the aforementioned fiber angle of a stored energy is less than **13.5 degrees per weight in near **12 degree as for maximum, a bird clapper, and this angle.

[0065] C. the thickness of the interlayer section / surface-layer section, and manufacture of the swirl spring according to the related example 2 with a stored energy per weight -- facing -- the thickness t1 of the outside surface-layer section, the thickness t3 of the inside surface-layer section, and thickness t2 of the interlayer section ******** -- it changed variously and measured about the stored energy (kg-cm/kg) per weight

[0066] First, thickness t1 of the outside surface-layer section Thickness t2 of the receiving interlayer section As a result of measuring about a ratio (t2 / t1), the property shown in drawing 5 was acquired. Thickness t1 of this property result to the outside surface-layer section Thickness t2 of the receiving interlayer section It turns out that maximum is obtained in the range of ratios 1.5-3.

[0067] Thickness t1 of the outside surface-layer section And thickness t3 of the inside surface-layer section When referred to as both 0.04cm, as a result of measuring about the time of making it change to thickness t2 =0-0.25cm of the interlayer section, the property shown in drawing 6 was acquired. That maximum is obtained from this property result for the thickness of the range of thickness t2 =0.025-0.2cm of the interlayer section, i.e., the interlayer section, in the 0.6 to 5 times as many range as this to the average thickness of both the surface-layers section, one side, and t3/t1 t3/t1 in which the maximum shows the maximum to in 1.25, and maximum exists It turns out that the range is about 0.5-3. In addition, as a result of performing same measurement in this case about a glass fiber strengthening resin, an aramid fiber strengthening resin, and spring steel, as compared with what is depended on an example 2, it was checked per weight that a stored energy is about 1/3 or less.

[0068] Next, the whorl spring concerning this invention mentioned above is used, and the equipment applied to the source of power which performs accumulation and discharge of energy is explained.

[0069] Application drawing 7 emits the energy which whirled, accumulated the drive rotational energy of the axis of rotation for the spring, and was accumulated at this whorl spring to the driving source side of the axis of rotation held suitably at the free rotation state, and shows the basic principle in the case of constituting so that necessary driving force may be given to this axis of rotation (recycling).

[0070] That is, in drawing 7 , the axis of rotation which connected the end to the necessary driving source (not shown) is shown, it is combined with end 40a of this axis of rotation 40 by the driving source (for example, engine of an automobile), and the reference mark 40 is combined with other end 40b by the passive-movement object (for example, wheel of an automobile). Thus, in the periphery of the constituted axis of rotation 40, it becomes the aforementioned example 2 from the composition of a publication, and whirls, and surrounding arrangement of the spring 42 is carried out.

[0071] Receipt arrangement of this whorl spring 42 is carried out between the inside support case 44 and the outside maintenance case 46, and surrounding covering of the aforementioned outside maintenance case 46 is further carried out in the whole with the external housing 48. In addition, it is fixed externally and the aforementioned external housing 48 holds the axis of rotation 40 free [rotation] through bearing 50 and 51 in the both ends, respectively.

[0072] However, it is equipped with the inside support case 44 of the aforementioned whorl spring 42 so that the axis of rotation 40 may be held free [rotation] through bearing 52 and 53 in the both ends of shaft orientations. On the other hand, joint wearing of the engaging and releasing of the aforementioned outside maintenance case 46 is enabled to the axis of rotation 40 through an one-way

clutch 54 and bearing 55 in the end section of shaft orientations.
[0073] furthermore -- the above -- a whorl -- a spring -- 42 -- the inside -- support -- a case -- 44 -- the axis of rotation -- 40 -- a side -- an end -- setting -- the axis of rotation -- 40 -- joining together -- having -- rotation -- a drive -- carrying out -- a clutch -- 56 -- engaging and releasing -- free -- combination -- composition -- carrying out -- having . Moreover, the end of the aforementioned inside support case 44 engages with bond-part 48a prepared in the medial surface by the side of the end of the external housing 48 through the one-way clutch 58.
[0074] In bond-part 48b prepared in the medial surface by the side of the other end of the external housing 48 on the other hand while combining the aforementioned outside maintenance case 46 with the axis of rotation 40 free [engaging and releasing] through the aforementioned one-way clutch 54 in other end side (load side) 40b of the axis of rotation 40, the brake bond part 60 which performs brake combination which can engage and release freely is constituted.
[0075] Next, accumulation / discharge operation of the energy of the whorl spring 42 in the equipment which consists of the aforementioned composition is explained.
[0076] First, while whirling with a clutch 56 and making the inside support case 44 of a spring 42 into an engagement state, the outside support case 46 and the external housing 48 of the whorl spring 42 are made into an integrated state by the brake bond part 60. Thus, if the rotation drive of the axis of rotation 40 is carried out in the direction of an arrow by the driving source, while carrying out free rotation of the aforementioned inside support case 44 to an one-way clutch 58, since the aforementioned outside support case 46 engages with the external housing 48 by the brake bond part 60 and it is fixed, the whorl spring 42 will be rolled from the inside to a necessary limitation, and bundle operation will be carried out. In addition, free rotation of the axis of rotation 40 is carried out to an one-way clutch 54 in this case. Moreover, when a driving source stops, while the whorl spring 42 winds and bundle operation is carried out by rotation operation of the axis of rotation 40 by the inertia of a load, this can do the operation of a brake to the axis of rotation 40.
[0077] However, in this case, although the outside maintenance case 46 tends to rotate in one with the aforementioned inside support case 44 on the occasion of the superfluous volume bundle beyond a necessary limitation, it is constituted by the amount of [of the aforementioned outside maintenance case 46 and the external housing 48] bond part so that the aforementioned outside maintenance case 46 can carry out slip rotation through proper slip equipment (not shown).
[0078] By such volume bundle operation of the whorl spring 42, necessary elastic strain energy can be accumulated for the aforementioned whorl spring 42.
[0079] Subsequently, if the engagement of a clutch 56 which is performing combination with the inside support case 44 of the aforementioned whorl spring 42 and the axis of rotation 40 is canceled after stopping the rotation drive of the aforementioned axis of rotation 40 By the energy accumulated at the whorl spring 42, although the aforementioned inside support case 44 tends to carry out rotation operation in the direction opposite to the rotation driving direction of the aforementioned axis of rotation 40 In this case, the one-way clutch 58 which combines the inside support case 44 and the external housing 48 will be in an engagement state, and free rotation will be prevented.
[0080] Then, if engagement of the brake bond part 60 which is performing combination with the outside support case 46 of the aforementioned whorl spring 42 and the external housing 48 is canceled, the aforementioned outside support case 46 tends to carry out rotation operation of the aforementioned outside support case 46 and the axis of rotation 40 by the energy accumulated at the whorl spring 42 in the same direction as the rotation driving direction of the aforementioned axis of rotation 40. At this time, as for the case of a low rotational frequency, an one-way clutch 54 will be from the rotational frequency which the axis of rotation 40 has stopped or the outside support case 46 tends to rotate in an integrated state, and the whorl spring 42 emits energy which was made to carry out rotation operation of the aforementioned outside support case 46 and the axis of rotation 40 in one, and was accumulated.
[0081] By this, when the axis of rotation 40 has stopped, a drive start will be carried out by the whorl spring independent, and when the rotational speed of the axis of rotation 40 is slow, a whorl spring will assist a driving source. In this case, it is desirable to form the equipment which controls the energy-release speed of a whorl spring, and to make it the rotational speed of the axis of rotation 40 not become large rapidly.

[0082] Thus, the energy which whirled by the rotation drive of the axis of rotation 40, and was accumulated at the spring 42 can be made to emit alternatively in the rotation driving direction of the axis of rotation 40 on the occasion of a drive halt of the axis of rotation 40, respectively by engaging-and-releasing operation of a clutch 56, the brake bond part 60, and an one-way clutch 58.
[0083] Thus, according to going down of a slope, or braking at the time of a slowdown, recovery accumulation of the energy is carried out at the whorl spring 42, and the function as the driving source at the time of a start and assistance of the lack of ability of acceleration of a driving source or the driving source at the time of a climb is demonstrated for this. Moreover, it is also possible to heighten the output of a driving source before a long climb, and to pre-enlarge the amount of stored energies of the whorl spring 42. In addition, when backing by the driving source, an one-way clutch 54 needs to be canceled. Moreover, when a load rotates by the driving source, if desorbed from the clutch 56, it is enough without receipts and payments of the whorl spring 42 and energy. And in case the driving source itself rotates reversely in this case, it is necessary to be desorbed from a clutch 56, to combine the brake bond part 60, and to cancel an one-way clutch 54.
[0084] Moreover, on the occasion of the discharge to the axis of rotation 40 of the energy accumulated at the aforementioned whorl spring 42, through an one-way clutch 54 or a clutch 56, in combination with the axis of rotation 40, it can constitute, respectively, with the aforementioned outside maintenance case 46 or the inside maintenance case 46 so that the speed control of the axis of rotation 40 by discharge of a stored energy may be smoothly attained to these bond parts by preparing speed governor styles applied to a time register, such as a temp and a pendulum.
[0085] Furthermore, it whirls, and when [which was mentioned above] using it on the occasion of use of a spring 42 in joint fixation with the both ends of the whorl spring 42, and a core side (for example, inside maintenance case 44) and an outside (for example, outside maintenance case 46), making the aforementioned whorl spring 42 distorted by the fixed safety within the circle, it is satisfactory by mere adhesion and a mere bolt stop. However, in the aforementioned whorl spring 42, fiber is arranged by one side and, moreover, it is necessary to distribute distortion or the force by which a load is carried out to all fiber when using it, making the aforementioned whorl spring 42 distorted to near the destructive limitation. Moreover, when the bending stress of the aforementioned spring concentrates on one place, a spring may break in the concentration part and it is not desirable.
[0086] then, a both-sides side [in / the edge 43 of the whorl spring 42 / as shown in drawing 8] -- receiving -- edge reinforcement -- adhesion fixation is carried out as it pinches by members 64 and 65 Thus, the aforementioned trouble is cancelable by strengthening the edge 43 of the aforementioned whorl spring 42, and attaching this by the method of adhesion and others to a predetermined bond part. Moreover, in the example shown in drawing 8 , although the whorl spring 42 wound and the end edge 43 was shown, the thing which do not illustrate and for which it can whirl and the same edge reinforcement member as the above can be attached also about the cut-water edge of a spring 42 is natural.
[0087] in this case, edge reinforcement -- while the composite material reinforced with a metal, fiber textiles, etc. can constitute members 64 and 65 -- this edge reinforcement -- members 64 and 65 -- the edge 43 of the whorl spring 42 -- the thing which are estranged more gradually and which is set up so that concentration of stress may be avoided, as it is alike, and it forms so that the thickness may become thin gradually, and follows and may curve with a spring is desirable in addition, the example shown in drawing 8 -- setting -- edge reinforcement of the whorl spring 42 -- edge reinforcement of the side joined to bond-part material among members -- if a member 65 (winding lateral surface of the end edge 43) is constituted so that the point 65a may be made to bend and project outside and it may be easy to be engaged, it is suitable Moreover, it constitutes so that the point of the side (namely, medial surface of a cut-water edge) which is not illustrated and which it whirls and is joined to bond-part material also about the edge reinforcement member of the cut-water edge of a spring 42 may be made to bend and project inside and it may be easy to be engaged.
[0088] In addition, in this application, in the composition shown in drawing 7 , although the case where the axis of rotation 40 was constituted as a single shaft was shown, combination side 40a with a driving source and combination side (load side) 40b with a passive-movement object can be separated, and these can also be considered as the composition combined through a proper shaft coupling.

[0089] It whirls, joint arrangement of the plurality of a spring is carried out in series, and drawing 9 emits again the energy which was mentioned above and which whirled, accumulated the drive rotational energy of the axis of rotation for the spring, and was accumulated at this whorl spring to the axis of rotation, and shows the application constituted so that necessary driving force might be given to this axis of rotation (recycling). In addition, about the same component as the component of explanation shown in aforementioned drawing 7 , the same reference mark is attached for convenience, and detailed explanation is omitted.
[0090] That is, in drawing 9 , a reference mark 40 shows the axis of rotation which connected the end to the necessary driving source (not shown), and connected the other end to the load, and consists of composition which adjoined one by one and carried out surrounding arrangement of two or more whorl springs 42a, 42b, 42c, and 42d which become the aforementioned example 2 from the composition of a publication in the periphery of this axis of rotation 40.
[0091] The whorl springs 42a-42d of these plurality about 42d of whorl springs of the first whorl spring 42a and the last It is held at the outside support case 46 and the inside maintenance case 44. about these whorl springs 42a, 42b, 42c, and 42d It is held in the connection cases 47a, 47b, and 47c which formed the inside maintenance case sections 44a, 44b, and 44c of a whorl spring, and the outside support case sections 46a, 46b, and 46c in one one by one, respectively.
[0092] In addition, in this application, the outside support case 46 is engaging with the external housing 48 through an one-way clutch 58 while combining with the axis of rotation 40 through the clutch mechanism 66 which consists of clutch fork 66a, clutch thrust bearing 66b, and multiple-disc-clutch 66c. Furthermore, some outside support cases 46 are equipped with sleeve 46' which extends to the aforementioned inside maintenance case sections 44a, 44b, and 44c and the inner circumference section of the inside maintenance case 44, and each aforementioned inside maintenance case sections 44a, 44b, and 44c and the inside maintenance case 44 are held free [rotation] through bearing 52 and 53 to this sleeve 46', respectively.
[0093] Moreover, in this application, the inside maintenance case 44 is engaging with the axis of rotation 40 through an one-way clutch 54 while combining with the external housing 48 through the brake joint mechanism 70 which consists of brake drum 70a, brake-shoe 70b, and brake cam 70c.
[0094] Other composition is the same as that of what is fundamentally shown in aforementioned drawing 7 . Therefore, also in the application shown in this drawing 9 , the operation is fundamentally [as the application shown in aforementioned drawing 7] the same, and is the point which constituted the whorl spring in the multiple string, and the feature is that it may increase the storage capacitance and discharge capacity of elastic strain energy.
[0095] As mentioned above, according to the composition of the whorl spring of this invention, a stored energy can be raised more sharply than the conventional thing. Therefore, when manufacturing energy accumulation equipment using this whorl spring, it is necessary to consider as the structure where the capacity of the aforementioned whorl spring is fully utilizable. And it is necessary to consider the destructive distortion of a whorl spring, and it is necessary to design housing and a paper winding shaft so that a spring may be distorted even to near [this] even distortion or near it. case it is common at least -- the diameter of a paper winding shaft -- fabrication -- it needs to be smaller than the diameter of metal mold Moreover, when a certain place is distorted to the point most early near destruction, designing, as other portions are distorted till the place almost near destruction will raise a stored energy. for this reason -- being alike -- it is with the circumference inside a spring, and the outside circumference, and it is desirable to design the pitch during the circumference so that it may ask for the curvature in a destructive time by experiment and destructive distortion may be reached thereby almost simultaneous
[0096] In addition, naturally variation exists in the destructive distortion of the mass-produced spring. Therefore, the use range must be safety within the circle [in consideration of variation]. For example, the diameter of a paper winding shaft is set up or a rotation arrester or slip equipment is suitably formed so that distortion by 80% or more of average breaking-strain Mino may not be received.
[0097] Moreover, in the whorl spring of this invention, distortion is received between outside housing and an inside paper winding shaft. When using the plurality of a whorl spring, making it in-series, an one housing [of a spring] and paper winding shaft side is made to connect one by one. In

this case, the spring diameter of an outside and the inside is regulated by housing and the paper winding shaft. However, since the periphery becomes small and each circumference of a spring gathers simultaneously to shaft orientations while the outside of a spring is pulled out, friction arises with equipment without such regulation, for example, a take-up spool method without housing, between the circumference. For this reason, a big hysteresis is produced on the occasion of expansion and contraction of a spring.

[0098] However, if housing exists, each circumference moves a periphery toward inside one by one with rotation of a paper winding shaft, not changed, there is little friction in comparison and a hysteresis is also small [friction] for this reason. Thereby, the accumulation discharge efficiency of energy also becomes high.

[0099] In addition, a hysteresis can be made small by making small the elastic modulus of the inside of a spring, or an outside. Moreover, a hysteresis can also be made small by lowering frictional resistance for the inside and the outside of a spring by mechanical processing. Furthermore, also by making the lubricant from which matrices, such as paraffin series oil, are not changed to the inside or the outside of a spring adhere to a front face, frictional resistance can be lowered and a hysteresis can be made small.

[0100] Furthermore, in the whorl spring of this invention, in spring deformation, it pulls in the outside surface-layer section, deformation arises, a compression set arises in the inside surface-layer section, and the portion which only bends in the pars intermedia of the thickness direction, and does not have deformation of the length direction arises. In order to utilize the capacity of the material used as hard as possible, when deformation breaks, it is desirable that all material has reached the breaking point. Therefore, outside the portion which does not carry out [aforementioned] length deformation (outside surface-layer section), a thing strong against tension deformation is desirable, and a thing strong against a compression set is desirable inside the portion which does not carry out length deformation (inside surface-layer section). Moreover, it is desirable to consider as the big thing of destructive deformation toward a front face in each. Thus, fiber and a resin can be chosen.

[0101] And although it may not necessarily be stratified, changing fiber toward pars intermedia from a front face disregards a productivity issue, and it is desirable. [of the class section] When the class section consists of two or more layers, such change is easy in comparison. By using an aramid fiber and a glass fiber for the outside layer of the outside surface-layer section, specifically, making an inside layer into a carbon fiber, using a carbon fiber for the front-face side (inside of a spring) of the inside surface-layer section, and using a boron fiber and a silicon carbide fiber inside (pars intermedia side of a spring), a desirable mode also forms so that a both layer all layer may break simultaneously.

[0102] In addition, by fiber being the same in the inside layer and surface layer of the inside surface-layer section, and using a thick thing for the diameter of a filament of fiber by the surface layer, compressibility-proof can be raised and simultaneous destruction nature can also be raised. Moreover, when the interlayer section in the air exists, it can constitute similarly.

[0103] As mentioned above, although the suitable example of this invention was explained, it is natural [this invention] that many design changes can be made within limits which do not deviate from the pneuma of this invention, without being limited to the aforementioned example.

[0104] In addition, it is what carries the cell and motor which were charged beforehand and assists human power with a bicycle as a hybrid driving gear using the conventional energy-conversion mechanism on a slope, for example, or is the hybrid drive formula automobile which uses a generator, a battery, and a motor (or AC machine which unified the generator and the motor). On the other hand, in the whorl (spiral spring) spring of this invention, turning effort is accumulated with turning effort, it uses as a turning effort as it is, and there is no conversion of energy, therefore excessive equipment is unnecessary. Therefore, compared with the conventional spring, it is improved remarkably and a stored energy can use the whorl spring of this invention as a useful means of a hybrid drive.

[0105]

[Effect of the Invention] this invention is started and it whirls so that clearly from the example mentioned above (spiral spring). a spring It constitutes from a composite which becomes two or more continuous glass fibers from the matrix resin which holds this to band-like. The mechanical

energy of rotation operation given from an external driving source and/or an external load is accumulated mainly as an elastic strain energy of a continuous glass fiber. While it constitutes so that the elastic strain energy by which accumulation was carried out [aforementioned] at the time of necessary may be taken out as a mechanical energy and a driving source may be assisted, and the aforementioned composite constitutes the surface-layer section of an outside and the inside By preparing the interlayer who consists of lightweight material for being inserted into both the surface-layers section and maintaining the distance between both surface layers, fabricating this in the shape of a whorl, whirling, and constituting a spring In case accumulation of a comparatively mass mechanical energy is enabled and deformation of the aforementioned composite is moreover restored by making the aforementioned composite transform mechanically, the accumulated mechanical energy can be emitted efficiently and it can utilize effectively as various kinds of sources of power.
[0106] Moreover, the whorl spring of this invention improves the stored energy per capacity, when preparing a middle lightweight layer, improving the stored energy per weight and not preparing a middle lightweight layer further. For this reason, if the textiles and knitting, and a nonwoven fabric are used, since an improvement effect will be lowered as a continuous glass fiber, it is not desirable. As for fiber, it is desirable that orientation is substantially carried out only to the longitudinal direction of a spring.
[0107] Therefore, by applying to the equipment which applied this to the source of power which performs accumulation and discharge of energy, the whorl spring concerning this invention can level change of a load, or as a means to level change of an energy source, it can use it in a wide range field so that it may illustrate below.
[0108] (1) When the heavy load of the means a. future which levels change of a load is expected, accumulate energy little by little, without hanging unreasonableness on a driving source beforehand, and assist the driving source at the time of a heavy load. For example, in a shuttle bus etc., it is possible by making it a navigator interlocked with and programming beforehand to prepare the energy for climbs. Moreover, in a bicycle, when a front long climb can be seen, an output is raised little by little from this side, a whorl spring can be rolled, energy can be accumulated, and a stored energy can be emitted at the time of a climb.
[0109] b. Whirl, accumulate the surplus rotational energy at the time of a low load for a spring, and assist an energy source at the time of a heavy load. For example, it can use for power load leveling by whirling by dump power, rolling a spring, accumulating energy, when there are few power requirements, and emitting, when power requirements are large.
[0110] c. Accumulate the mechanical energy usually diffused as heat at the time of braking for a whorl spring, and this assists the energy source at the time of the usual rotation. For example, it whirls at the time of **** of an automobile, a bicycle, and a train, or a slowdown, a spring is rolled, energy is accumulated, and a stored energy is emitted at the time of a climb or acceleration. In addition, an elevator is applicable similarly, and if it is an energy source, it will not necessarily be limited to what drives an object.
[0111] (2) In the means a. wind power which levels change of an energy source, on the occasion of the drive at the time of a strong wind, it whirls, accumulate energy for a spring, emit a stored energy on the occasion of the drive at the time of calm, or the time of a low wind, and attain equalization of a power generation output.
[0112] b. In current power generation, a cell is substituted, it whirls, and a spring is used, accumulate energy for this swirl spring, emit a stored energy on the occasion of the time of a non-tidal current or a low-water style, and attain equalization of a power generation output.

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] The swirl spring characterized by constituting from a composite which becomes two or more continuous glass fibers from the matrix resin which holds this to band-like, and constituting so that the mechanical energy of rotation operation given from an external energy source and/or an external load may be accumulated mainly as an elastic strain energy of a continuous glass fiber, the elastic strain energy by which accumulation was carried out [aforementioned] at the time of necessary may be taken out as a mechanical energy and an energy source may be assisted.
[Claim 2] The accumulation of energy to the swirl spring by the load is a swirl spring according to claim 1 which constitutes and becomes so that the energy which a load has may be collected, it may whirl at the time of the brake operation to a load and a spring may be given.
[Claim 3] For a continuous glass fiber, a tension elastic modulus is 2 40,000 kgf(s)/mm. It is the following and tensile strength is 2 250 kgf(s)/mm. Swirl spring according to claim 1 which it mainly comes to constitute from fiber which it is above.
[Claim 4] A continuous glass fiber is a swirl spring according to claim 1 which comes to carry out orientation to a band-like longitudinal direction.
[Claim 5] A composite is a swirl spring according to claim 1 with which consist of a bilayer at least and it comes to arrange a continuous glass fiber within each class in the same direction, respectively.

[Claim 6] The swirl spring according to claim 4 or 5 with which a longitudinal direction comes to arrange a continuous glass fiber with the inclination of less than **13.5 degrees to a band-like longitudinal direction.
[Claim 7] The swirl spring according to claim 1 to 6 the continuous glass fiber located in the band-like outside wound in the shape of a swirl is a kind of fiber chosen from an aramid fiber, a carbon fiber, a glass fiber, and a polyethylene fiber at least, and is [spring] a kind of fiber chosen from a carbon fiber, a glass fiber, a boron fiber, and a silicon carbide fiber in the portion located inside at least.
[Claim 8] The whorl spring characterized by having constituted the surface-layer section of an outside and the inside from a composite which consists of two or more continuous glass fibers and a matrix which holds it to band-like, and turning the interlayer section lightweight from the aforementioned surface-layer section.
[Claim 9] The whorl spring according to claim 8 which comes to form a part for a centrum in the interlayer section.
[Claim 10] The whorl spring according to claim 8 which comes to constitute the interlayer section from lightweight material which has a part for a centrum.
[Claim 11] The whorl spring according to claim 9 which comes to constitute a part for the centrum of lightweight material from a micro balloon.
[Claim 12] For a continuous glass fiber, a tension elastic modulus is 2 40,000 kgf(s)/mm. It is the following and tensile strength is 2 250 kgf(s)/mm. Whorl spring according to claim 8 which it mainly comes to constitute from fiber which it is above.
[Claim 13] A continuous glass fiber is a whorl spring according to claim 8 which comes to carry out orientation to a band-like longitudinal direction.
[Claim 14] The composite of both the surface-layers section is a whorl spring according to claim 8 with which consist of a bilayer at least, respectively, and it comes to arrange a continuous glass fiber within each class in the same direction, respectively.
[Claim 15] A continuous glass fiber is a swirl spring according to claim 13 or 14 which a longitudinal direction comes to arrange with the inclination of less than **13.5 degrees to a band-like longitudinal direction.
[Claim 16] The whorl spring according to claim 8 to 15 whose continuous glass fiber of the surface-layer section located inside the continuous glass fiber of the surface-layer section located in the band-like outside wound in the shape of a whorl is a kind of fiber chosen from an aramid fiber, a carbon fiber, a glass fiber, and a polyethylene fiber at least, and is a kind of fiber chosen from a carbon fiber, a glass fiber, a boron fiber, and a silicon carbide fiber at least.
[Claim 17] The whorl spring according to claim 8 with which the thickness of the interlayer section

it is thin from lightweight material consists of 0.2 to 6 times of the average thickness of both the surface-layers section.
[Claim 18] The whorl spring according to claim 8 with which the thickness of the interlayer section it is thin from lightweight material consists of 0.6 to 5 times of the outside surface-layer section.
[Claim 19] The swirl spring according to claim 8 which constitutes and becomes so that the aforementioned energy which accumulated the mechanical energy of the rotation given from an external energy source and/or an external load mainly as elastic strain energy of a continuous glass fiber, and was accumulated at the time of business may be taken out as a mechanical energy and an energy source may be assisted.